MAKING A GROUND PLANE AERIAL

R. F. GRAHAM

THE ground plane aerial provides low angle radiation and omnidirectional coverage. It was decided to try such an aerial, as a change from the dipoles, long wires and doublets previously favoured, and after comparing the signal strength of a number of stations who themselves were using ground planes.

For those not familiar with the ground plane, Fig. 1 gives the essential details. The vertical element (usually self-supporting, though it can be wire) is a ¼-wave long for the chosen band. Each radial is usually a little longer. At least four radials are recommended, more or less evenly spaced round the pole. They also act as guys. The whole is as high as convenient above surrounding objects, and can be fed with 50Ω co-axial cable. The cable inner conductor goes to the bottom of the vertical element, and the outer conductor to all the radials.

Constructional Work

It was apparent that the whole could be prepared and put up in two or three hours. Clamps were made from 1½in. wide strips of stout sheet metal, Fig. 2. These were fashioned by taking two round pieces of wood, one the size of the pole and the other equivalent to the vertical element, shaping the strips to suit in a vice, and drilling them for 2in. long 5/16in. bolts. Stout gauge tubing was used for the vertical, and seemed in no danger of collapsing.

The radials were 14s.w.g. aerial wire, looped through two turns of similar wire round the pole. This was drawn tight, twisted, and all joints were soldered. (A large iron is needed.) The co-axial outer conductor is soldered to the ring (radials). The inner conductor is bolted to the vertical element. Joints, and the exposed end of the co-axial insulation, are painted to keep out moisture. The co-ax was stapled a little way down the pole, to take stress off the end.

It was found that the whole could be easily raised into a vertical position, using the method for lifting a long ladder. The bottom end of the pole is pivoted on a post, tied to a strong peg, or placed against something which will not allow movement outwards. The top end of the pole is then raised above the head with both hands. Walking towards the pole base and simultaneously moving hand over hand along the pole raises it. The pole was tied temporarily to its post, and the radials loosely attached to surrounding objects (a tree, post, and house). The pole was then raised to its higher position (Fig. 1) and the radials drawn tight at 45 degrees to keep it vertical.

Dimensions

The aerial erected was designed for near 14·2Mc/s. The vertical was 16ft. 6in. and each of the four radials was 17ft. long. The standing wave ratio was better than 1·5:1 throughout the 14—14·35 Mc/s band. The pole was 18ft. long, fixed with its bottom

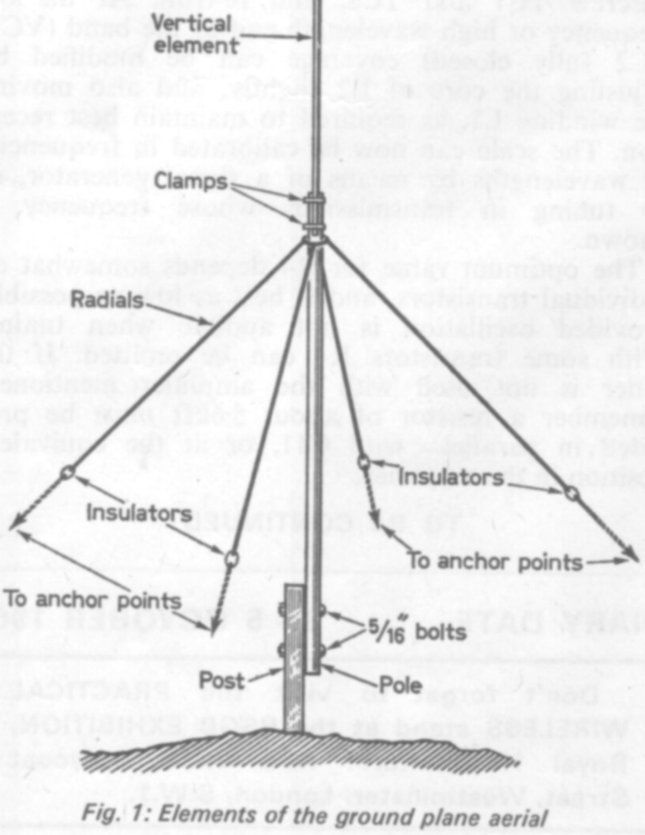

Fig. 1: Elements of the ground plane aerial

end 5ft. above the ground. For the 10m or 15m bands, the length of the vertical, in feet, can be found from 234M/cs. The radials are a trifle longer, equal to 240Mc/s.

Feed impedance is low with the radials at 90 degrees to the vertical element (e.g., horizontal) but rises as the radials are sloped downwards. An angle of about 45 degrees is suitable for 50Ω co-ax feed, this cable being any length. If circumstances permit, the ends of the radials can be raised or lowered, and the effect on the SWR noted.

Results

When first used with a receiver, the ground plane furnished results of about 5/5 from Australia, South Africa, Philippines, Guiana, and other prominent distant signals. Nearer ranges, such as USA, were around 5/7 to 5/9. Closer stations, and Europeans, were generally well up in strength, and one SP (Poland) station also using a ground plane gave a reading of 20db over S9.

When transmitting, the ground plane allowed the P.A. to be easily loaded by adjusting the pi tank capacitors. When used with a transceiver in which the method of tuning and particular i.f. caused bad 80m breakthrough on 20m with a long wire, the breakthrough disappeared. This was a great benefit when listening.

The best long distance contact reports were 5/5 with VK and ZL (Australia, New Zealand). This was with 150 watts input. The relative polarisation of aerials, depending in this case on the polarisation used by the other station, seemed to have no bearing on signal strength. On the basis of the reciprocal relation between receiving and transmitting with a given aerial, the ground plane seemed sometimes better and sometimes worse than a dipole and long wire, as would be expected. In any case this relationship does not hold for long distance short wave transmission. Equipment used was free from TVI with horizontal aerials. As the home and other local TV aerials were vertical, it was thought that TVI might commence with the ground plane. But in this particular instance TVI was also absent with the ground plane.

The final opinion was that the ground plane was quite a useful aerial to have, and that its actual construction was not a matter of much difficulty. With radials at 45 degrees, such an aerial as that described requires a minimum diagonal space of about 25—26ft., or a square of about 18 × 18ft. ■

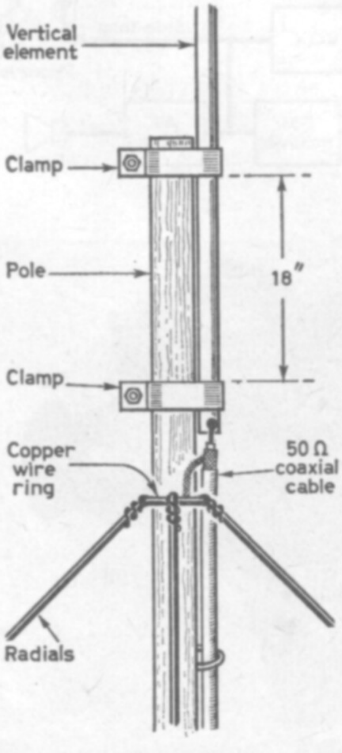

Fig. 2: Details of fitting etc.

Five steps to hi-fi

PART ONE . . . . . . PICK-UPS

IAIN SMITH

A HIGH fidelity sound system can be considered as a chain with the pick-up, turntable, amplifier and loudspeaker each being the individual links making up the chain. It is often said that the amplifier is the strongest link in the chain, which is true. It is also said that the loudspeaker is the weakest link in the chain. This is not true. The loudspeaker is suspect for several reasons; one being that the average loudspeaker is between 5 and 10 per cent efficient, another being the loudspeaker's tendency to produce Doppler distortion (more of this later in the series).

There is, however, a far weaker link producing far more distortion, namely, the pick-up. The pick-up transducer itself does not produce any significant distortion. Most distortion is produced at the point of contact between stylus and groove, the stylus mounting and cantilever with pick-up arm construction providing another distortion factor. An important feature of any pick-up head is its "compliance".

Compliance

The compliance of a pick-up transducer as used in record reproduction can be defined as "the ability of the stylus to trace accurately the pattern of modulations of the recorded groove without damage to the groove walls". Compliance is measured as the distance in centimetres that the stylus will move for a thrust of 1 dyne. This distance is usually very small and normal compliances are in the order of units x 10^{-6}. Two compliances are usually stated for stereo pick-ups; a lateral and a vertical compliance. All pick-ups have a lateral compliance but for safe tracking of stereo records, a vertical compliance is the one and only essential factor. This is because stereo records have modulations on each groove wall, which are at forty-five degrees to the vertical, therefore, some vertical motion is unavoidable.

By the above definition a good compliance is one which allows the pick-up to track the record without damage to the grooves. A figure of 5 x 10^{-6}cm/dyne laterally and 2 x 10^{-6} cm/dyne vertically is about the minimum acceptable to meet this condition. Obviously, higher figures than this are better. The compliance of a pick-up determines, to some extent, the output from the pick-up. With high compliance pick-ups there is so much flexibility in the stylus cantilever or coupler that a movement of the stylus by the groove only produces a small movement of the transducer hence a smaller output. This is why high output crystal pick-ups used with low sensitivity amplifiers, found in portable record players, have a low compliance. Because of the low compliance a high tracking weight, around the 10 gramme mark, is usually necessary which is not very healthy for records.

Stylus Tip Mass

Another factor affecting the wear on records by pick-ups is the stylus tip mass. It is thought by some authorities to be *the* most important factor and experiments carried out so far confirm this. Tip mass is the mass of the stylus as seen by the groove of the record. This is not related to tracking weight, as mass is effective in all directions not just vertically. Many expensive pick-ups have a tip mass of 3 milligrammes. Experiments have shown that this, even when combined with a high compliance, produces measurable record wear. It is thought that something less than 1½ to 2 milligrammes is desirable. The Decca Deram ceramic stereo pick-up has a tip mass of 0·6 milligrammes. This pick-up shows no measurable record wear after 250 playings under a 400 times magnification. Its compliance 9·0 x 10^{-6} lateral and 5·0 x 10^{-6} vertical is also somewhat less than some expensive pick-ups with a 3 milligramme tip mass, whose performance cannot compare.

Other factors affecting performance are tracking weight and electrical impedance. Tracking weight should be as low as the compliance allows but within the manufacturer's specification. Too little tracking weight causes more record wear, slightly more than is necessary.

Impedance

The electrical impedance required by the pick-up as a load should be matched by the input impedance of the amplifier. If the impedance, presented as a load to the pick-up, is too low, then a loss of the lower frequencies will result. Little effect will be noticed by putting a larger load than required across the pick-up. The minimum voltage required by the amplifier to drive it should also be matched by the maximum output of the pick-up.

Pick-up heads should be mounted in a lightweight shell coupled to a lightweight arm. This is to reduce the effective mass of the arm as seen by the stylus, thereby reducing lateral forces which cause record groove deformity. Friction in vertical and lateral pick-up arm bearings should be as low as possible, again to reduce lateral and vertical forces. Certain bearings such as brass bush and spindle types have limitations in this respect. Bearings should at least be of the small ball type.

The type of pick-up arm material affects pick-up performance. Plastic is notorious for causing resonance and die-cast aluminium is only one step better. Best materials are tubular aluminium or low resonance wood.

Another way in which pick-up arm construction affects performance is the angle at which the head is offset. Unless the stylus cantilever is tangential to the portion of the groove beneath it, distortion in the output waveform will be set up (see Fig. 1). The reason for the distortion is that it is direct lateral movement of the stylus that creates the output and the resultant movement of the stylus in the diagram would not conform to the recorded pattern.

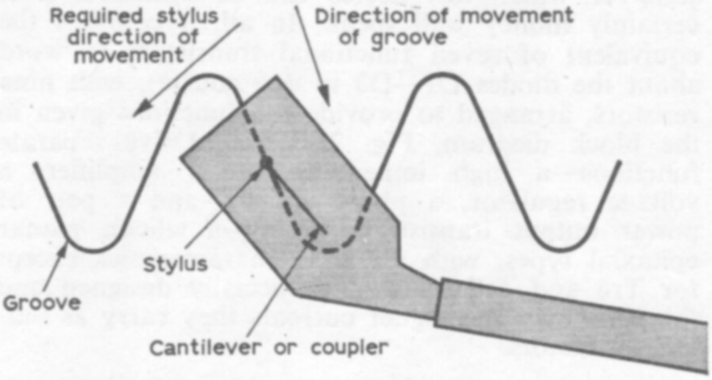
Required stylus direction of movement
Direction of movement of groove
Stylus
Groove
Cantilever or coupler

Fig. 1: An illustration of how tracking error occurs through the pick-up being incorrectly offset.

A method of checking for tracking error is as follows. Take an old disused 78 r.p.m. disc and draw a line across the diameter. Mark a point on this line 2½in. from the record centre. With the stylus placed on this point the pick-up head should be at right angles to the diameter. If there is more than a three degree error, this should be corrected if the arm is of sufficient length. Correction can be made by either moving the pick-up head along the arm or by adjusting the arm length. Distortion caused by tracking error will be more noticeable towards the centre of the record.

Buying Guide

To sum up here are the main points to look for when purchasing a pick-up.

1. The pick-up should have a high compliance.
2. The tip mass should be less than two milligrammes.
3. The electrical impedance and output should be matched to the amplifier.
4. The pick-up arm bearings should be of the low friction type.
5. The pick-up arm construction should be of low resonance material.
6. The pick-up arm construction should be of such a length as to avoid tracking error.

Obviously a book could be written on this subject but the points outlined in this part should prove helpful.

to be continued

SATELLITE EARTH TERMINALS

APRIL ISSUE, PAGE 915

We regret that due to a printers error, the power of the signals referred to in the 28th line, second column, was given incorrectly.

This should read "...10^{-18}watts" and not 10 watts as stated.

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